

Knowledge Use in Knowledge Building Discourse

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Abstract Although many research on knowledge building process is carried out, still little is known how the knowledge information is used in the knowledge construction discourse, i.e. the use of knowledge information that we provide in education or the 'valid knowledge sources' (scientific and professional literature, experts). The use of authoritative knowledge sources is one of the principles of knowledge construction. To explore this gap, KBDeX network analyses have been carried out into the way in which two MEd student groups from a Masters in Learning and Innovation use 'curriculum' literature in their knowledge-constructing dialogues. On basis of the analysis crucial phases/activities patterns in the discourse could be identified. These discourse activities concern: Group forming: sharing everyone's 'acquired' insights and finding a substantive socio-cognitive match; Collective engagement: loosening one's own egocentric perspective and becoming involved in a collective knowledge construction dialogue; Grounding: 'dialogue' about what exactly everyone means with seemingly clear terms that are used; Integration and construction: accommodation, creation of collective and therefore own ideas by integrating and connecting ideas that transcend previous ideas (rising above); and finally writing or creating the conceptual artifact. The transition from one discourse activity to another seems to be supported by "bringing-our-knowledge-together" transgressions. These are contributions in which a state of affairs is drawn up and relationships are established between topic terms and their own ideas at that time. The results support the idea that learning is a psychological process and that knowledge emerge in students' actions in particular in their in-(ter)-actions with each other and in their world.

Introduction

Diverse studies have analyzed the knowledge building discourse. For instance Ma, Matsuzawa, & Scardamalia, (2016) found patterns of temporary rotating leadership in their analyses of social networks in knowledge-constructing conversations of primary school students. They discovered a relatively decentralized student network. Van Heijst, de Jong, van Aalst, de Hoog, & Kirschner (2019) studied the socio-cognitive dynamics in knowledge building discourse of MEd students in a master's in Learning and Innovation from the perspective of openness. In general, moderate openness was expressed in the contributions in the students' virtual conversations. The social openness appeared to be much higher in the contributions than the cognitive openness. It is all the more striking that of the four social and four cognitive expressions of openness in the student contributions, three of the cognitive openness expressions led to more follow-up contributions in the knowledge-constructing conversations than the social openness expressions. The social openness expressions appeared to have no effect at all on the continuation of a conversation.

Despite this kind of studies and those of others (Thomas, Li, Knott, & Li, 2008; J Zhang, Chen, Tao, Naqvi, & Peebles, 2014; Jianwei Zhang et al., 2014) there is still little insight into how the knowledge information offered in a curriculum is used in the discourse activity of knowledge construction, i.e. the use of knowledge information that we provide in education. In terms of knowledge building principles: the use of 'authoritative knowledge sources' (scientific and professional literature, experts) (Bereiter, 2002; Paavola & Hakkarainen, 2005; Scardamalia, 2002; Scardamalia & Bereiter, 2014). De Jong, (2019, 2020) looks at these resources as information sources (cold knowledge) which are transformed into (warm, meaningful) knowledge by students' actions. So, also by the actions in students' in-(ter)-actions. Such as, for example in the knowledge building dialogues. The process can be sketched as meaning making interaction process involving – in an almost phenomenological sense – letting 'that which shows itself be seen from the way it shows itself' (Heidegger, 1977, p. 34). Also, Gal'perin sees, building on Vygotsky's attention to speech, signs and symbols (their semiotically mediated meaning-making) and Leontiev's notion of 'activity', action as the basis for developing the meaning of these semiotic tools. According to Leontiev, the human mind has its origins in external activity

from which it transformed. Thus, the human mind is not something relative to external activity. For him, human cognition and external activity are products of one another (Engeness & Lund, 2018). Heritage ((2012)) says that epistemic or knowledge positioning occurs in conversational turns through the actions in a dialogue. This contrasts with knowledge as a hidden individual, internal, mental action. Coulter (1983, p. 128) had already argued that ‘people’s “*mental*” properties should be seen as originating from situated, constitutive (*qualifying, conditioning and founding*) practice’. This knowledge positioning is calibrated in social interaction with others (recipient-designed), who monitor, actively test and respond to the stance taken (Mondada, 2019).

To explore this meaning making process in students’ in-^(ter)-actions during knowledge building dialogues, KBDeX network analyzes (Jun Oshima, Oshima, & Matsuzawa, 2012a) have been carried out into the way in which two MEd student groups from a Masters in Learning and Innovation use 'curriculum' literature in their knowledge-constructing dialogues. Questions in the study were:

- What role does that information from authoritative resources, i.e. topics, concepts, words that cover the topics in the literature (topic terms), play in the in-^(ter)-actions that students use to develop their conceptual artifact?
- What is the nature of the actions in which those topic terms perform their connecting function during the discourse?
- What does this say about the in-^(ter)-actions and the process of knowledge emergence?

Method

The data comes from online discourse contributions in the interactions of MEd master students in the trimester course building their vision on learning. It can be deduced from the instruction of the course component that it is more about an "idea-centered" activity than a "task-centered" activity: "(...) *the most important starting point is knowledge creation. The fact that teachers want to join them in a knowledge creation process leads to collective and individual insights. Insights that arise from a "design mode" to deal with information. (..)*" (Course introduction to students in the course manual, 2019). This indicates that the focus of the course is not on the most beautiful representation of theories, but on the elaboration of the ideas of students they have gained by reading and working with those theories. "(...) *Obviously, that requires a good understanding of it.(...)*" (Course introduction to students in the course manual, 2019). Scardamalia (2002) calls this constructive use of authoritative sources. It is a process from the "collective idea" to your own ideas and vice versa. "*Another important starting point for the course is that it is about*" (...) *describing "learning" as a phenomenon, as a process. For this it is not only useful to gain a lot of insights, but it is also necessary to know your own vision and views on learning and to test what you will be encouraged to do.*" (Course introduction to students in the course manual, 2019).

Subjects

Two subgroups of N=4 students each, that were the most active in online discourse were selected from a year cohort. Active in the sense that both groups had substantial amount of contributions in a Knowledge Forum dialogue environment as a group N= 192 and N=191 contributions. Each subgroup comprised three women and one man between the ages of 26 and 55. Students all had a working position as a teacher or as human resource developer. They followed this two-year part-time MEd Learning and Innovating program in order to professionalize oneself in innovating their practice. (because of European privacy law we cannot give further detailed information).

Analyses

To analyze the constructive connections, we used KBDeX (Knowledge Building Discourse eXplorer), a content-based social and temporal network analysis tool (Jun Oshima, Oshima, & Matsuzawa, 2012b). The present analyses concern the relationships between the semantic, social topic terms that have been created. They concern relationships that arise as students build on one another’s input –in other words, shared ideas through the co-occurrence of topic terms in discourse contributions. The advantage of using KBDeX and co-occurring terms is that it makes the form of the connection transparent, thus making it easier to investigate the semantic connections in their network of the dialogue. This maximizes the transparency of knowledge-building processes. Other studies have also used co-occurring term concepts via semantic analyses to test knowledge development (Hong & Scardamalia, 2014; Ma et al., 2016; Matsuzawa, Oshima, Oshima, Niihara, & Sakai, 2011).

The KBDeX social semantic network analysis (SSNA) method was crucial in the analysis because our data source was the Knowledge Forum dialogues conducted by the Master of Learning and Innovation students within the Learning theme with a view to arriving at a collective vision of learning. Students shared their ideas in the Knowledge Forum by posting contributions in a two-dimensional, virtual, collective workspace. The students' online discourse discussions were imported into KBDeX in order to perform the content-based social semantic network analyses (SSNA). KBDeX allows us to investigate discourse in real time. For example, if you click on a key term in the word network, the discourse units in the discourse unit network in which the key terms simultaneously occur will also show up in red, and so too will the authors of the discourse units. (see Figure 1).

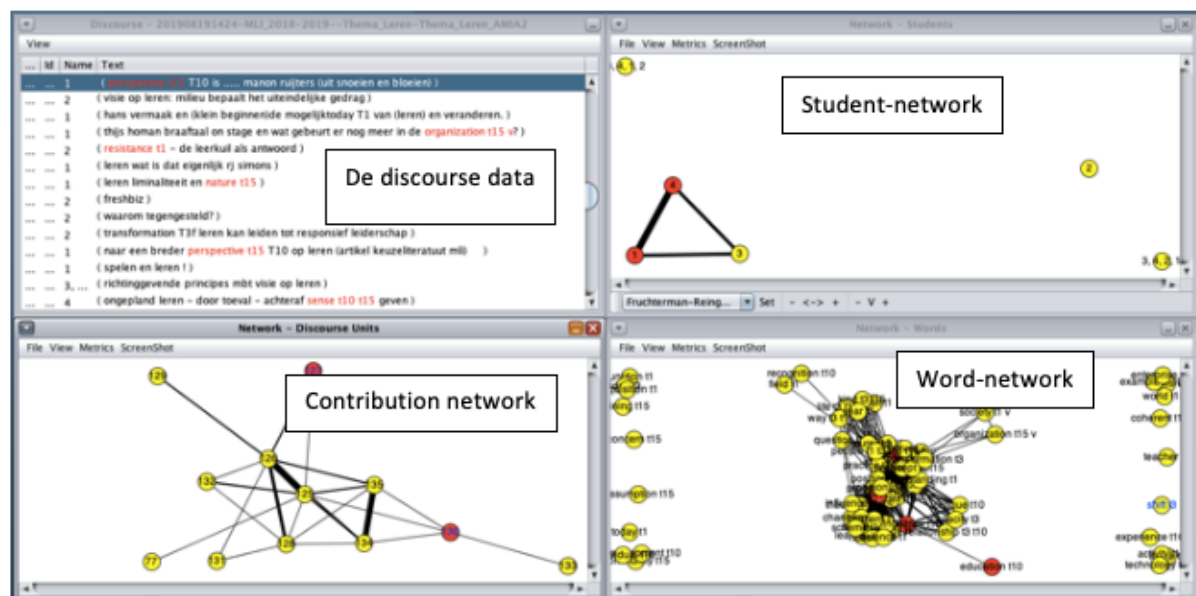


Figure 1, KBDeX window: The thickness of the lines shows the strength of the relationships, calculated on the number of discourse-paired units that share a term.

This functionality was used to investigate the discourse in depth as a way of validating the strength of the betweenness centrality value, based on Natural Language Processing (NLP), topic modelling and topic terms. The 'centrality' indicates the importance of a discourse unit, a term (concept) or an individual in the contribution to and the strength of the network (see also (Ma et al., 2016; J Oshima, Matsuzawa, Oshima, & Niihara, 2013; Jun Oshima et al., 2012a). The higher the centrality value, the stronger the contribution to the network's development. A centrality value of 1 means that the influence, proximity, or contribution to the network is high, whereas a value of 0 means that there is no influence or proximity, or that no contribution is made. Thus, if a discourse unit integrates previous ideas, it contributes more to proximity and degrees of centrality coefficients than ones that integrate fewer or no ideas.

The knowledge construction productivity and creativity are interpreted by the decentralized network structure through the firm adherence to certain topic terms that are leading. Analogous to the rotating leadership phenomenon in a social network (Ma et al., 2016), it can be assumed that the changing connecting force in the course of the interaction of available topic terms in studied authoritative sources has a meaning in this. Topic terms that remain in the periphery of the discourse make little contribution. Topic terms that regularly change from the periphery to the core of the discourse, on the other hand, make a strong contribution to productivity and creativity, and thus to the success of knowledge development in the in-^(ter)-action.

We took the core literature from the set texts, namely Illeris' (2009) Contemporary theories of learning. The students were asked to study Chapters 1 (Illeris), 2 (Jarvis), 4 (Engeström) and 10 (Tennant) for the second session in the first month and Chapters 3 (Kegan), 6 (Mezirow), 15 (Lave & Wenger) and 16 (Wildemeersch) for the third Learning theme session in the second month. These chapters were subjected to an NLP topic modelling analysis (see Figure 2). The rationale behind topic modelling is that meanings are relational (Joseph, 2011). Topics are associated with a group of words that occur frequently (Ignatow & Mihalcea, 2016). The resulting group of words can also be interpreted as lexical fields, groups of words whose meanings depend on each other; together, they form a conceptual structure that is part of a particular activity or specialist field

(Geeraerts, 2010; Saeed, 2015), such as a lexical field associated with school (e.g. teacher, book, notebook, pencil, student, etc.).

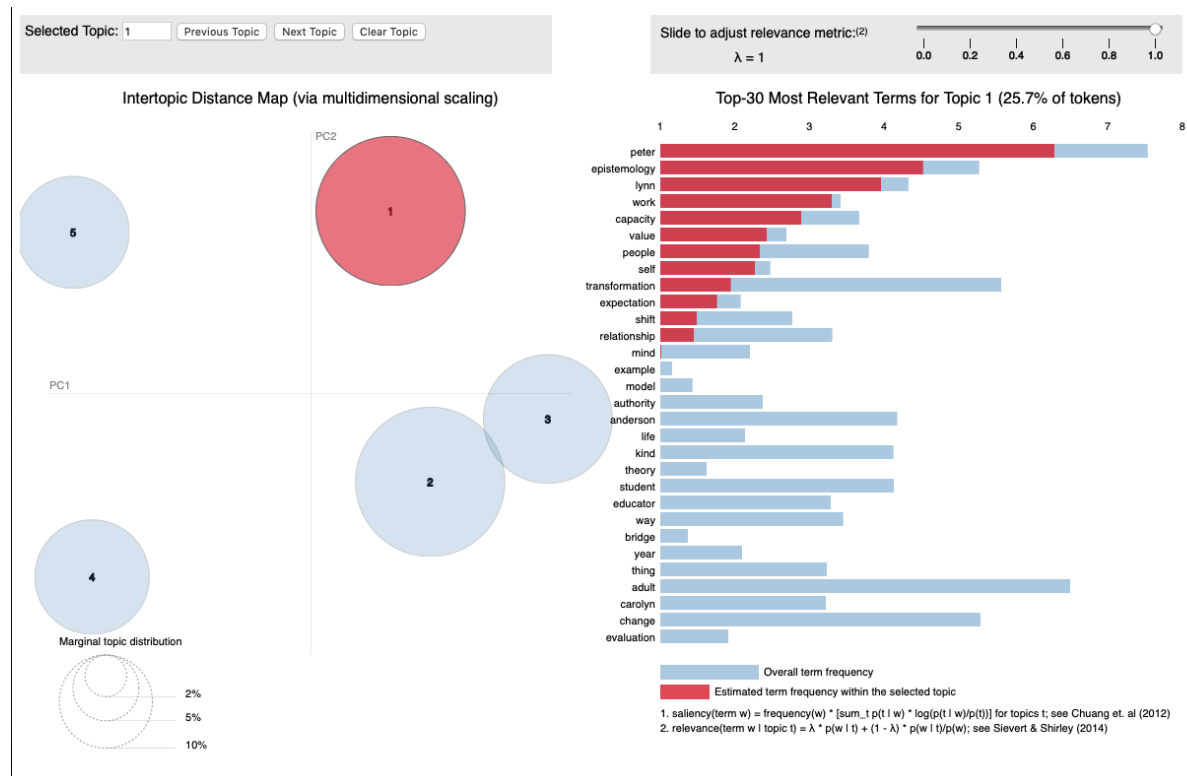


Figure 2. NLP topic modeling of one of the chapters in Illeris (2009), Contemporary theories. Blue represents the total frequency and red the estimated frequency of the term within the selected 'topic'.

For the SSNA used in KBDeX, for each chapter, we selected the most frequent terms in all topics in the chapter. For the analyses, we selected two chapters that students were asked to study for the second session (Chapters 1 and 10) and two (Chapters 3 and 15) for the third session. Chapter 1 was chosen because it sets out Illeris' overall theory and all students were likely to have read it. The other chapters were selected because they closely aligned with the visions of two selected subgroups of students. This also created a balance between the first and second periods of study, and in the distribution of chapters across the book. Chapter 1 has a strong constructivist, cognitivist orientation. In chapter 10, Tennant emphasizes a strong postmodernist view of eliminating the dualism between object and subject and post-humanist 'self'-orientation. Chapter 3 presents Kegan's strongly epistemic transformative vision of learning. Chapter 15 deals with the social learning theory of Wenger's communities of practice (COP). Also included in the SNA alongside the topic model terms for each subgroup were terms that the group 'appropriated', in students' visualization of the collective vision of learning, their conceptual artefacts.

Results

The betweenness centrality was examined at topic-term level for each group. In Figure 3, the y-axis shows the betweenness centrality value and the x-axis shows the time. Each topic term is represented by a colored line. The oscillation of colored, overlapping lines shows the rotating strength of connection of topic terms. This means that the connecting term concept with the highest centrality value at any given time changes frequently during the discourse.

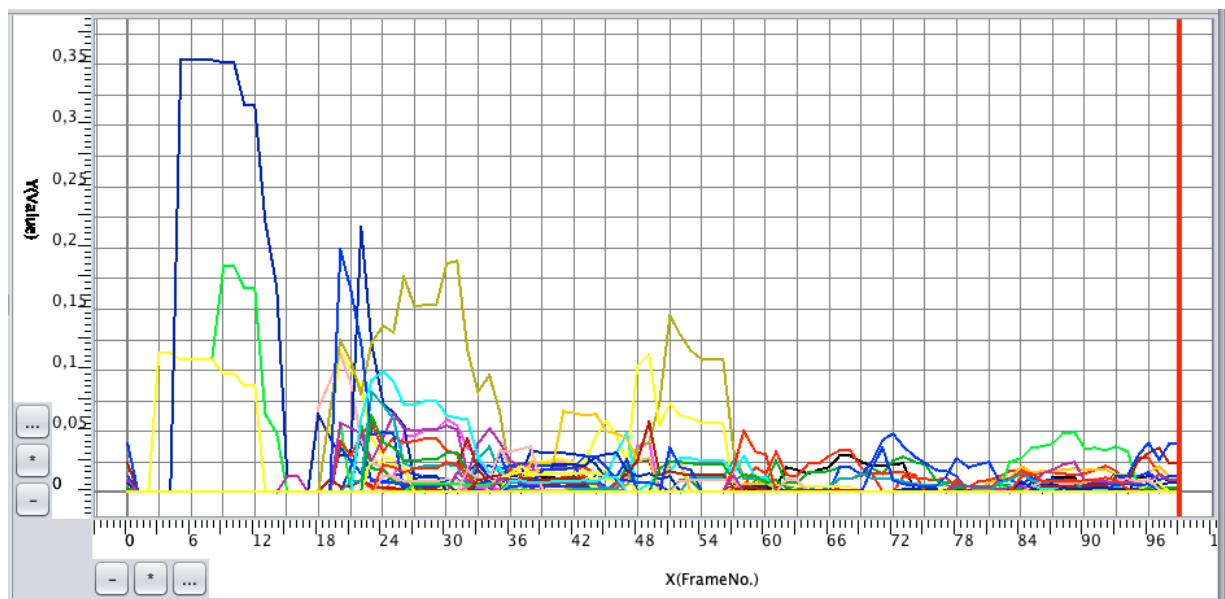


Figure 3: The between centrality at term level in the word network for group A

Of the 117 term concepts in the analysis of Group A, 13 function to a greater or lesser extent in a constructive, connecting position. Of these, six have a maximum betweenness centrality of more than 0.10: Knowledge (v) 0.353, Result (t1) 0.198, Organization (t15/v) 0.188, Community (t15) 0.184, Team (v) 0.116 and Position (t10) 0.112. This means that these topic terms had a 'connecting' function during the discourse, or knowledge building dialogue. The other somewhat connecting terms had centrality values of <0.067 and >0.035 , or even zero (v = a key term in the students' conceptual artefact; t15 = a key term coming from the NLP analyses chapters where the number indicates the chapter).

Of the 118 key term concepts in the analyses of group B, 11 are functioning to a greater or lesser extent in a constructive connecting position (see Figure 4), 2 of which have a centrality value above 0.1: Way (t3, t10, t15) 0.444; Notion (t10) 0.243. This means that these two topic terms were the most strongly "binding" in the course of the discourse or the knowledge-constructing dialogue. The other topic terms had a centrality value between <0.076 and >0.043 or even zero.

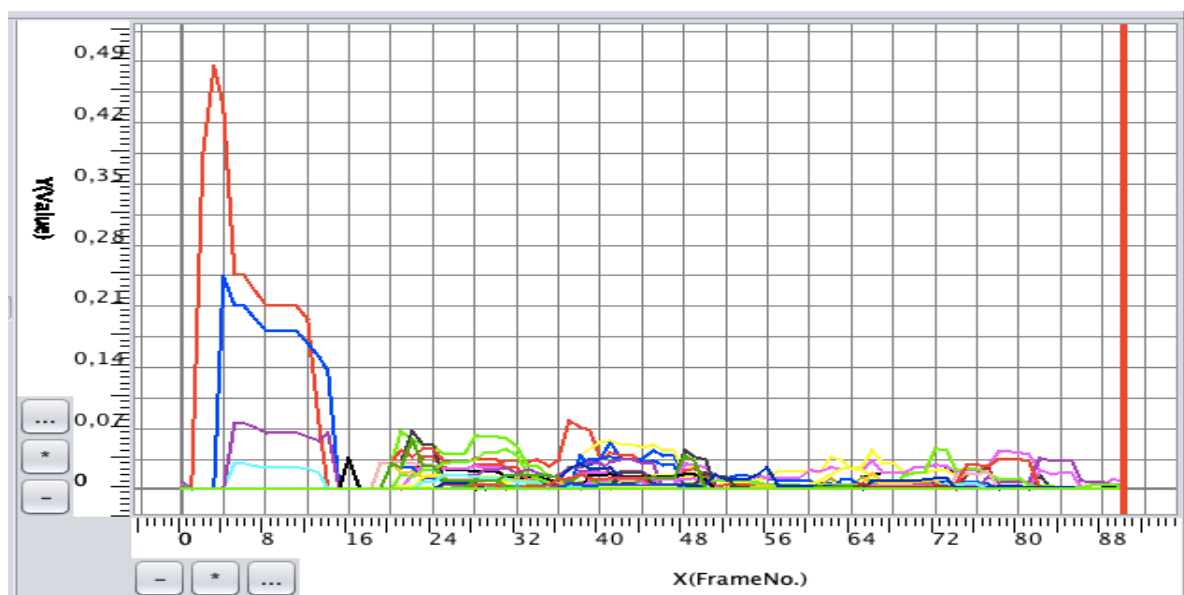


Figure 4: The between centrality at term level in the word network for group B

Inspecting Figures 3 and 4, we indeed see that in the starting phase of the discourse both groups are strongly influenced by certain topic terms. In the subsequent discussion activities, group A was more strongly influenced by certain topic terms that linked the sub-dialogs than group B. In the activities at the end of the discourse, the two groups appear to be more equal. We also see that in the visualization of the topic terms in Figure 4 where group B is much more diffuse in its topic terms and group A uses more compact topic terms in its vision construct. Although the groups studied the same literature, we see that both groups only use the same topic terms in their discourse: Position (t10) and Process (t1 t10 t15).

The differences of the visual inspection are confirmed in a MANOVA analysis with the connecting centrality as a dependent factor and the groups A and B as a group factor. There appears to be a significant effect in the connecting centrality of the overall topic terms. So not all concepts are equal in their unifying force in the discourse. There is also a significant effect between groups A and B in the connecting centrality (see Table 1).

Table 1: MANOVA results with the betweenness centrality values as within factor and group as between factor.

Multivariate Tests ^a									
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power ^c
Intercept	Pillai's Trace	,889	16,493 ^b	62,000	128,000	,000	,889	1022,583	1,000
	Wilks' Lambda	,111	16,493 ^b	62,000	128,000	,000	,889	1022,583	1,000
	Hotelling's Trace	7,989	16,493 ^b	62,000	128,000	,000	,889	1022,583	1,000
	Roy's Largest Root	7,989	16,493 ^b	62,000	128,000	,000	,889	1022,583	1,000
group	Pillai's Trace	,884	15,707 ^b	62,000	128,000	,000	,884	973,840	1,000
	Wilks' Lambda	,116	15,707 ^b	62,000	128,000	,000	,884	973,840	1,000
	Hotelling's Trace	7,608	15,707 ^b	62,000	128,000	,000	,884	973,840	1,000
	Roy's Largest Root	7,608	15,707 ^b	62,000	128,000	,000	,884	973,840	1,000

a. Design: Intercept + group

b. Exact statistic

c. Computed using alpha =

Qualitative analysis of the students' contributions connected to the key terms at the moment the key term has a high degree of betweenness centrality value exposes different phase or activity during the discourse. Group A's discourse is characterized by the use of many 'authoritative' sources. From their focus on Illeris, it is mainly chapters 1, 3, 10 and 15, and the students' 'own' concepts from their vision, such as Knowledge, that played a connecting, constructive role from the beginning in developing their vision of learning. For instance, at the discourse in this group unit containing the topic term Community, we see that both Students Three and Four made a contribution. Student Four integrated (the activity) in turn 4, in particular with Community and the topic terms Team (v), Structure (t15), School (t1 t13) and Knowledge (v) (see Figure 5). Student Three integrated (the activity) in turn 2, in particular with Community (t15) and the concepts Question (t10), Team (v), Self (t3, t10) and Process (t1, t10, t15) (see Figure 6). Both students also contributed in relation to the topic term Team (v) in their turns (2 and 30). A little later, Knowledge (v) played a connecting role in the turns of students One and Four. This had already happened with Student Four (turn 30), who, when describing their innovation in their work context, integrated in particular (cognitive) Knowledge (v) with Community (t15), Team (v), Structure (t15), School (t1 t13) and Practice (t10 t15) (see Figure 7).

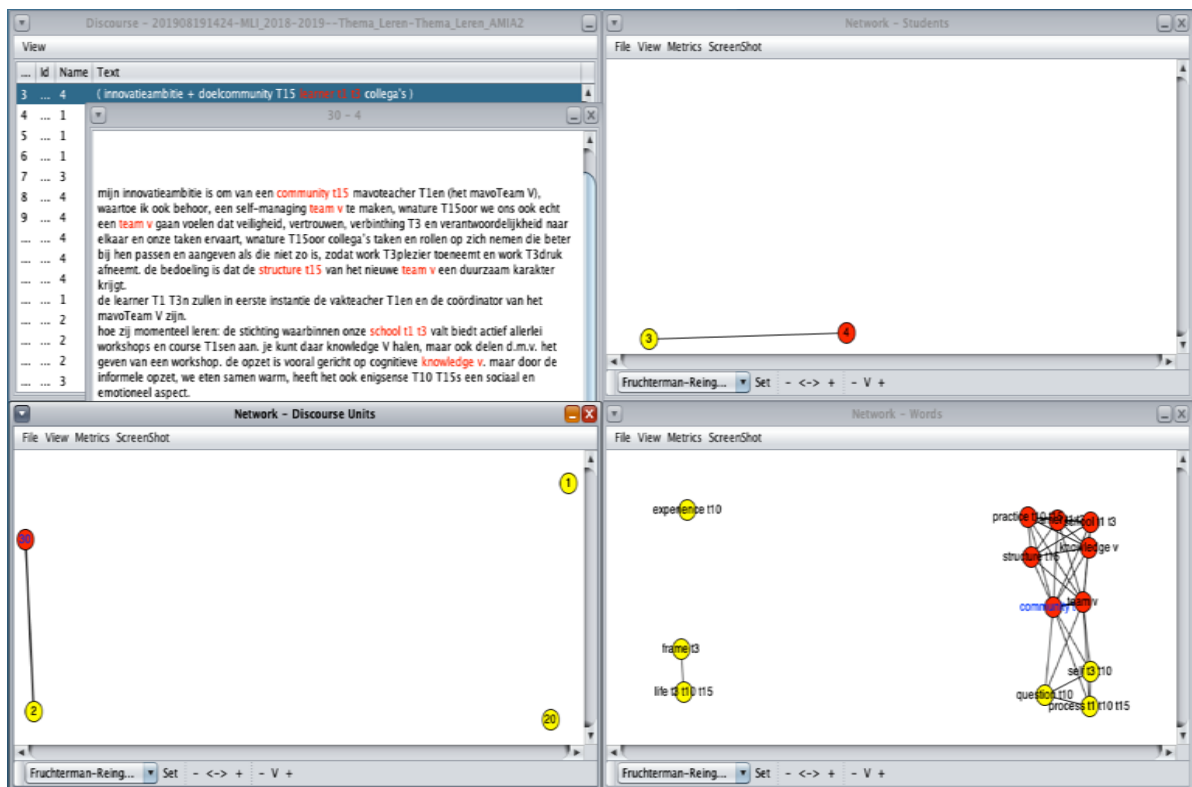


Figure 5: Student Four's turn, with a high betweenness centrality for Community and Team

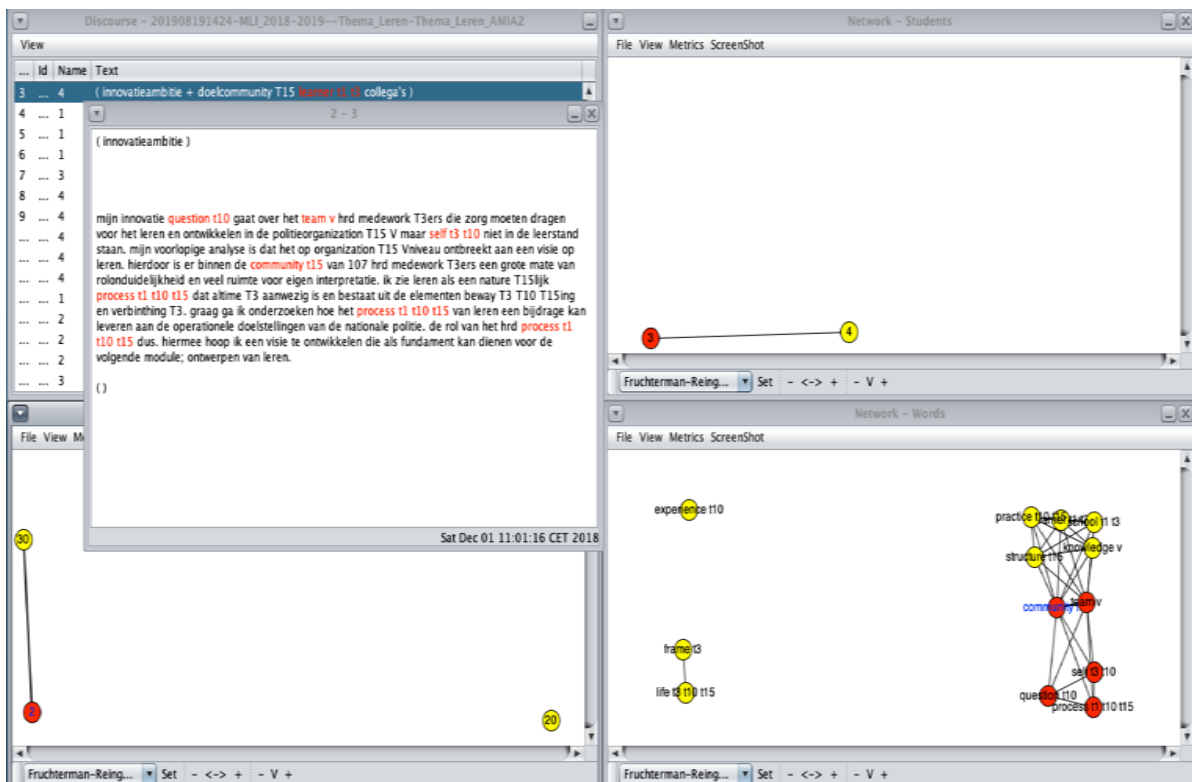
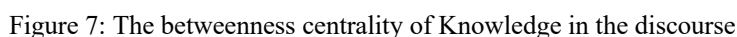


Figure 6: Student Three's turn, with a high betweenness centrality for Community and Team



Group B's discourse is characterized by a brief activity that moves from individual to collective engagement (Figure 8, lower picture), as well as by a very lengthy grounding activity that continues until the end. This involves summarizing the theory and guest lectures and, towards the end, alternating or parallel personal opinion-forming and meaning-making (about what they felt was meaningful) and the creation of their collective vision. Thus, in the final 'bringing our knowledge together/rise-above' we see more topic terms that also appear in the conceptual artefact. Group B adheres closely to the literature in their discourse and in their description of their vision of 'learning'.

1. Identify a socio-cognitive match;
Breaking free from the egocentric perspective and become involved in a collective knowledge construction dialogue;
2. Deepening by ‘grounding’: ‘What does someone mean by a term?’;
3. A moment of ‘bringing-our-knowledge-together’;
4. In-depth final activity of Accommodation, creation of collective and own idea.

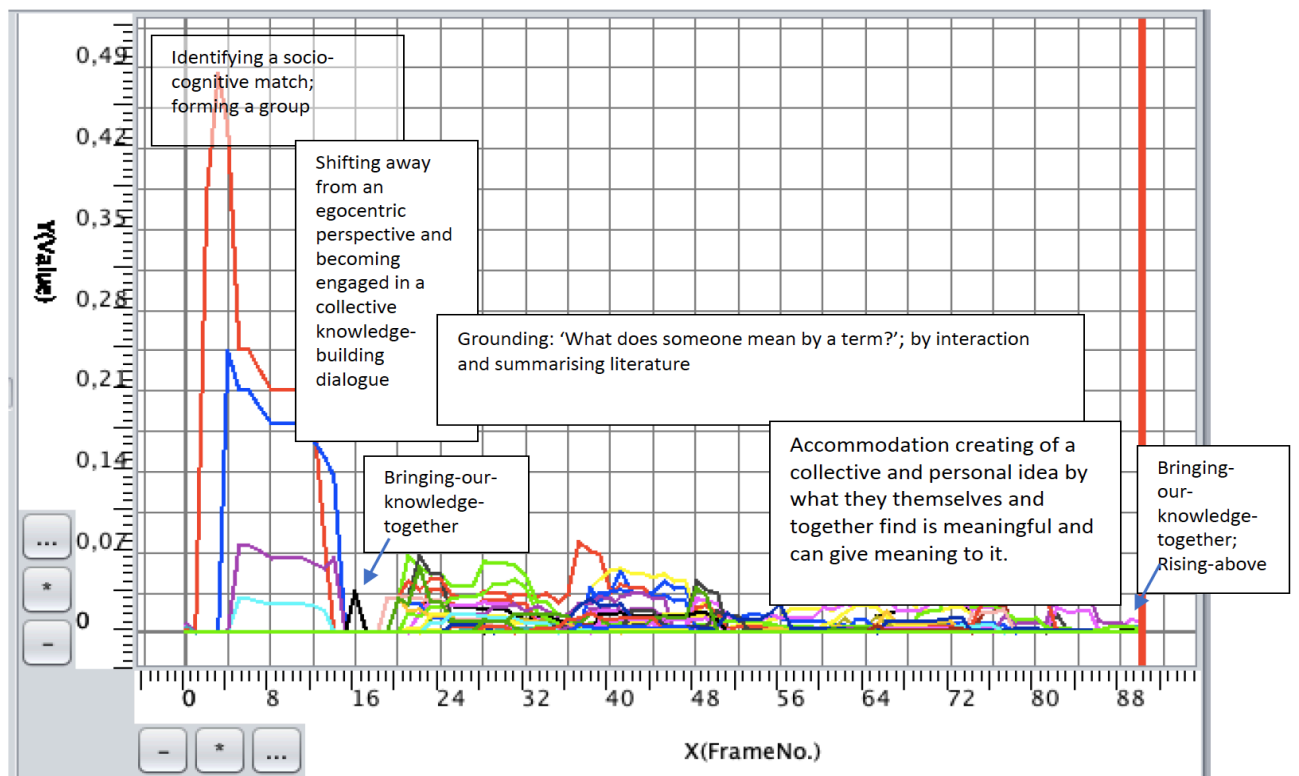
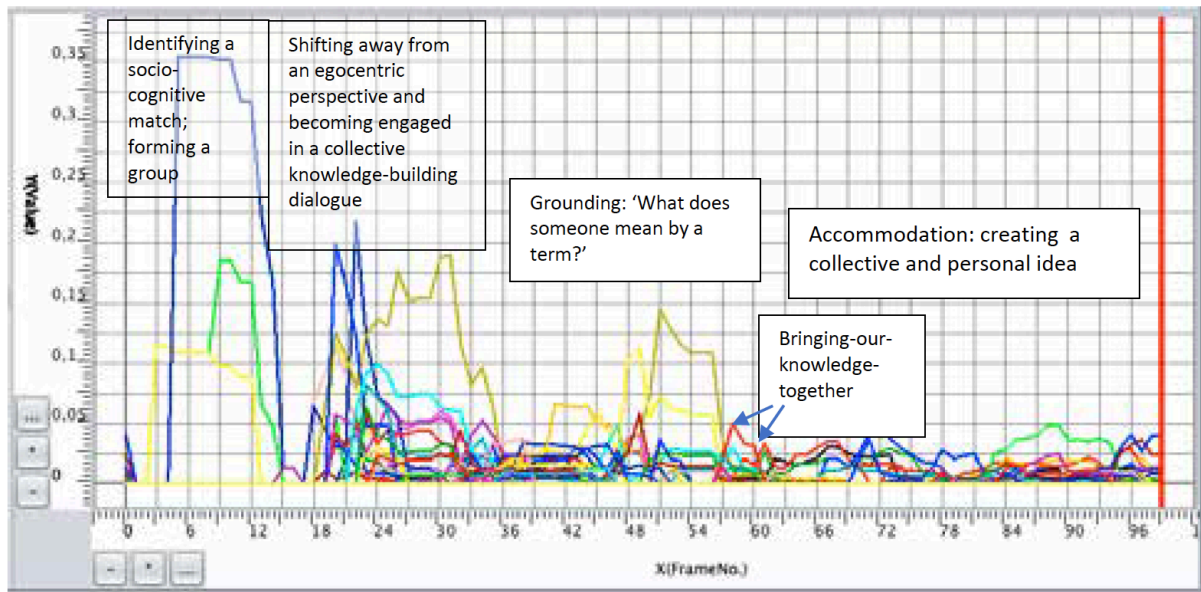


Figure 8: The between centrality and discourse activities on term level in the word network for group A (upper) and group B (lower).

Conclusions

The role that information of authoritative resources (i.e. topics, concepts, words that cover the topics in the literature (topic terms)) play in students' in-(ter)-action to develop their conceptual artifact is different in groups.

Certain number of topic terms have stronger relationships with each other than others in the knowledge construction or the development of the group vision on learning in the one or another knowledge building group. The lack of such topic terms in a dialogue can considerably disrupt knowledge construction because so many relationships (geodesic paths, "surveying paths") continue to other topic terms. In group B there is less centralization and there is a less coherent or looser relationship between a number of topic terms and topic terms have a more diffuse influence in the construction of the knowledge and / or vision that group B develops collectively.

The study reveals a nondominant nature of the actions in which those topic terms perform their connecting function during the discourse. The frequent changing of the connecting function over the topic term concept during the discourse means that the discourse is not dominated by one concept, but explorations and deepening of concepts take place in which different topic terms play a constructive connecting role.

Although, different topic terms have this connecting roles in the two knowledge building discourse groups same kind of patterns or discourse activities can be recognized in the knowledge construction process and is in line with the hypothesis and findings of De Jong (2015, 2019); Harashim (2017); Vogel & Weinberger (2019). We can identify different activity patterns in the knowledge-building process in which topic terms play an instrumental, connecting role:

1. *Group formation*: the collective knowledge-building process begins with an activity in which the insights 'acquired' by everyone are shared and a socio-cognitive content-based match is sought, giving rise to group forming through a sense of connection in relation to content.
2. *Collective engagement*: this is a process of moving away from one's own egocentric perspective and engaging in a collective knowledge-building dialogue. The purpose of reading information changes from seeking confirmation of one's own ideas to looking for what helps to find an answer to a collective question, testing promising collective ideas (theory), curiosity or solving a problem.
3. *Grounding*: a 'dialogue' about what exactly everyone means by seemingly clear terms in everyday use. Both groups did this by delving into the literature and discussing it with one another. It is a zone of non-resistance, where students come together, overcome their prejudices and recognize their interdependence in order to arrive at a shared transdisciplinary understanding (Brockwell, 2019).
4. *Integration and construction*: accommodation, creation of collective and therefore individual ideas by integrating and connecting ideas that rise above prior understanding; ultimately writing or creating a conceptual artefact.
5. The transition from one discourse activity to another appears to be supported by "bringing-our-knowledge-together" and 'rising-above'. These are contributions in which students take stock and establish relationships between topic terms and their own idea at that time

In these knowledge building discourse activities, knowledge experiences (experiences in practice, studying literature, conversations, etc.) transform into images, concepts and ultimately into theoretical insights. The collective activity in the knowledge construction process of students is the engine of developing their new insights with emergent their 'conceptual artifact' as a reflection of their new way, psychological functioning, looking at the world and his / her responsiveness and relationship with others and their surroundings.

The educational learning process in knowledge building programs is based on active and collective exploration and understanding the deeper essences of issues. In addition, students acquire powerful conceptual skills to think critically, independently and yet collectively, to develop perspectives, and to develop insights and ideas that contribute to the design of ecologically responsible solutions. It helps students to develop their analytical, historical, linguistic and social thinking, and their epistemic skills in such a way that not only they become wiser, but also their environment. Knowledge building discourse is a talking together that has to be learned and be supported by teachers. The above reported results helps us to understand the learning discourse. We don't have enough space in this article to go in detail about practical takeaways educators and teacher trainers might be able to use in their practice. However, De Jong (2019, 2020) is describing concrete activities for students, teacher, technology support in relation to knowledge building principles on base of above-mentioned activity phases in the knowledge building discourse.

The results are also a source for the reconceptualization of cognition as an internal information processing process into cognition as embedded in, present in, performed in the world and embodied in biology (Embedded in, Extended to, Enacted on to the world and Embodied in biology). Parada & Rossi (2018) see this reconceptualization as one of the frameworks that the development of psychological science needs to identify and study mechanisms that initiate outward-directed activities facilitated by ever-present neurological, inward-facing

activities. These mechanisms do not concern the reductionist mechanistic if-then statements, but contemporary complex and dynamic learning mechanisms, focused on development and construction instead of "learning" as information processing.

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